Regional Operations Centre
Canadian Coast Guard – Pacific

PACIFIC REGION CCG VESSEL - POST CRUISE REPORT
Line P Program – Fisheries and Oceans Canada

NAME OF SHIP/PLATFORM: John P Tully

DATE: **FROM:** 16 August 2016 **TO:** 31 August 2016

SCIENCE CRUISE NUMBER: 2016-08 **SHIP'S PATROL NUMBER:** 16-06

CHIEF SCIENTIST[S]: Marie Robert

SCIENTIFIC PERSONNEL:

Female	Male
Moira Galbraith (IOS)	Michael Arychuk (IOS)
Sara Heimlich (NOAA)	Glenn Cooper (IOS)
Krista Kulczycki (UVic)	Robert Izett (UBC)
Marie Robert (IOS)	Richard Nelson (BIO)
Jade Shiller (UBC)	Steve Romaine (IOS)
Amanda Timmerman (UVic)	
Theresa Venello (UVic)	
Sara Zeidan (U. Ottawa)	

AREAS OF OPERATION: North East Pacific, Line P, Station P.

INTRODUCTION/PROGRAM BACKGROUND: Line P is a long standing program which surveys a 1400 km long section 3 times annually. Data has been collected along this line since 1956 and shows evidence of the impact of climate variability on ocean productivity. It is the only Canadian long time-series that allows scientists to monitor climate changes in the Pacific Ocean. It is also the best opportunity for other programs (e.g. Universities) to do research in the Pacific since the Line P data give them background as well as current water properties.

CRUISE OBJECTIVE/OBJECTIVES: Repeat hydrography section (physics, chemistry, zooplankton), repeat service the NOAA subsurface mooring NRS-01.

CRUISE DESCRIPTION: This cruise (2016-08) went extremely well. Having a full 24 hours to load all the gear at the beginning of the cruise without rushing was the first step. The almost perfect weather was the second step. Finally, everything just simply worked well. There were some road blocks – like the winch repair that took four evening hours while the rosette was at 900 m – but there was a will to make things work that was fantastic. On this cruise we used the CTD/Rosette, the bongos, and the MPS (Multiple Plankton Sampler or Multinet). We also serviced the subsurface NRS02 mooring that was supposed to be serviced last June.

DAYS ALLOCATED: 15 **DAYS OF OPERATION:** 15

DAYS LOST DUE TO WEATHER: None. A few profiles had to be done on the way back.

SAMPLING:

- The Line P survey was 100% successful. The two bongos at Station P8 could not be performed on the way out but we had time to do them on the way back. The 3000 m Multinet cast at Station P got replaced by a 1500m bongo because of the winds picking up quickly. All planned stations were visited and all planned profiles got done.
- No drifters of any kind were deployed (no deployment was planned).
- Trace Metal samples were not collected on this cruise.
- We collected some extra "Deep Conductivity Sensor" data for Clark Richards at RBR Ltd.
- Many loops samples were taken for Salinity, Nutrients, Chlorophyll, Dissolved Oxygen (Lab), Dissolved Oxygen (Transducer room), and Gases.
- The samples collected include:
  1) Underway: **IOS**: Thermosalinograph (Temperature, Salinity, Fluorescence), acoustic sounder, ADCP, pCO_2 – **UBC (Izett):** dissolved nitrogen, oxygen, carbon dioxide, and argon (main lab); surface O_2 and total gas tension (transducer room), particulate back-scatter and spectrally-resolved absorption spectra.
  2) "E-data" from CTD: Pressure, Temperature, Conductivity, Dissolved Oxygen, Transmissivity, Irradiance, Fluorescence.
  3) From the Rosette: **DFO-IOS:** dissolved oxygen, salinity, nutrients, DMS, DMSP, chlorophyll, pigments (HPLC), dissolved inorganic carbon (DIC), alkalinity, pH – **DFO-BIO (Nelson):** Cesium, ^{129}Iodine – **UBC (Shiller):** high-resolution bacterial DNA sequencing, number of cells per millilitre, single cell DNA analysis, virus analysis, viral counts – **UBC (Izett):** methane and nitrous oxide (N_2O), carbon-14 (^{14}C) uptake experiments – **UVic (Timmerman):** ONAr, dissolved oxygen, triple oxygen isotope, dual tracer incubations, NH4, nutrients, chlorophyll, trace metal, salinity, ^{18}O, phytoplankton, noble gases – **UVic (Venello):** secondary productivity, zooplankton (for E. Pakhomov, UBC) – **U. Ottawa (Zeidan):** Cesium, Uranium
  4) **DFO-IOS, UVic and U. Ottawa (Galbraith, Venello, Zeidan):** Zooplankton using vertical net hauls (Bongos to 250 m, 1200 m, and 1500 m, and multinet to 3000 m).

RADIOISOTOPE USE:

C^{14} was used. The rad van was in good working order – thanks Mike for providing a new refrigerator/freezer!
The Rad-Van got decommissioned at the end of the cruise and approved by Michael Arychuk, RSO on board.

PROBLEMS [SCIENTIFIC GEAR AND OPERATIONS]:

For this cruise we had to bring the old PCO2 system because three days before the cruise the LICOR on the new system failed and had to be sent back to the factory for repairs. The old PCO2 system worked well for the first four days of the cruise but then developed an intermittent problem that plagued the system for the remainder of the cruise. Some troubleshooting was done but it was nearly impossible to isolate the problem to one specific part of the instrument due to the transient nature of the errors. The entire system will have to be disassembled back in the lab, in a more controlled environment, to properly diagnose the problem. For all intents and purpose the PCO2 data for this cruise is incomplete and unreliable and should be noted as such in the records.

Michael Arychuk

The CTD computer became infected with a virus at the beginning of the cruise, causing loss of several features, including the task bar and internet. The infection was removed after successfully installing a malicious software removal tool and two different virus removal software packages. The default anti-virus software on the computer was missing from the system. This caused a small delay on the first couple of stations. Recommend that the software regularly be checked on this machine, including updates of Windows when alongside and the presence of the anti-virus software.

Steve Romaine

Both label printers where delivered without their power supplies to the computers. Supplied totes need to be checked that all parts are present both before and after any cruise.

Steve Romaine

The dissolved oxygen analysis kit had a few issues; see report in Appendix, page 10.

SUCCESSES [SCIENTIFIC]:

This was the first cruise to use the cage system for loading of gear beyond what has traditionally been done by the plankton group and the mooring group. Three cages were set up in the chemistry staging area and were delivered to the ship along with additional cages from the Water Properties shop and the plankton group (total 5 cages). The Tully has purchased a cage-lifting device to ensure a safe loading of the cages onto the ship without the use of straps. Cages were stored in the hold during the cruise and were re-loaded at the end of the trip on the aft deck. To make the process more efficient, OSD scientists need training on the use of the flatdeck truck at IOS and OSD should consider the purchase of a forklift as forklift availability is a regular problem when ships are in port. The cage system saves the extra loading and unloading into vehicles to take items between IOS and the ship, but fragile items still need to be loaded in vehicles.

Steve Romaine

PROBLEMS [SHIP'S EQUIPMENT/OPERATIONS/PLATFORM SUITABILITY]:

There appears to be a film of oil or hydraulic fluid on the back deck, leading to awkward slips, flips and flies. This should be addressed; even though the majority of the slickness has been cleaned up there are still some spots where it is easy to slide.

Moira Galbraith

There were problems at the beginning of the cruise to get enough flow for the loop system and salt water on aft-deck, but the proper settings were eventually made and the flow was satisfactory for the rest of the cruise.

While trying to find a ground some breakers were turned off in the engine room which affected some computers in the "TSG corner" of the lab. It would be good if there was a UPS plug in that corner.

The CTD Hawboldt winch (s/n 17027) was making strange noises throughout the cruise. During the upcast of the deep Papa cast it got worse and the winch stopped at ~1765 m. After consulting with the Bosun and Chief Engineer we decided to bring the rosette on board as soon as possible, i.e. without doing the necessary 30 sec stops to close the Niskins (therefore compromising our samples). But at ~900m the winch totally stopped. The coupling was disintegrated and there was nothing left of the bushing. It took about 4 hours to fit the winch, while the rosette remained 900m below the surface. Fortunately the weather was perfect and the wire didn't get damaged. During this repair it was also noted that the flange plate has a few cracks.

SUCCESSES [SHIP]:

We had two officers of the watch who were pretty much new at station keeping, and definitely new at our science program. They did a fantastic job. Thanks Andrew and Brock!

Thanks to Andrew too for getting the Grib file and weather forecasts every morning.

The internet signal lasted until station P20 on the way out; we normally lose it ~80 miles before that.

It was a great idea to hose down the conducting wires with fresh water on the last deep casts in order to protect them from sea-water damage.

It was also very useful to have the mats covering the hoses on the aft-deck. This action greatly reduced the tripping hazard.

The TSG got rearranged on the grating so that it takes less space in that corner. Thanks!

DELAYS [OTHER THAN WEATHER]:

4 hours to fix the main Hawboldt winch.

SAFETY CONCERNS:

The decks were very slippery.

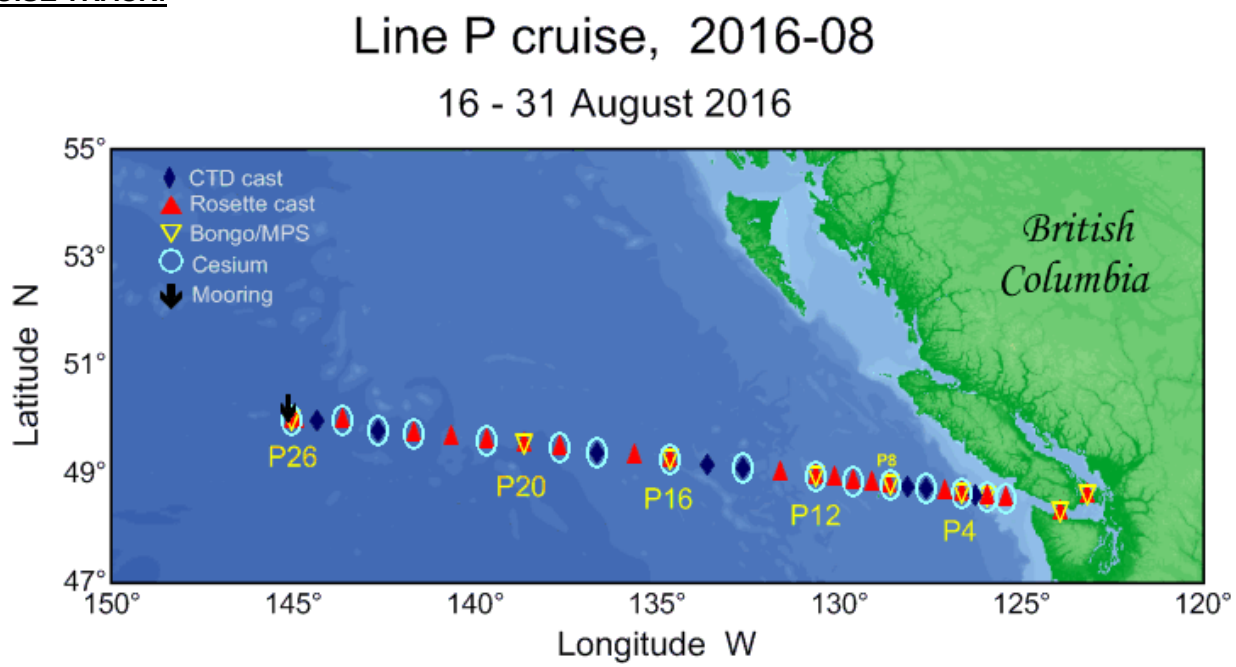
HAZARDOUS OCCURRENCES:

One person fell on the aft-deck because of the slippery decks.

EVENT LOG:

Tuesday 16 August:	Start loading scientific gear around 1330.
Wednesday 17 August:	Keep loading. Safety meeting at 0900. Science meeting at 1100. Leave Pat Bay at 1230. Fire and boat drill at 1300. Test cast in Saanich Inlet. Station Haro59 and JF2.
Thursday 18 August:	Stations P1 to P4.
Friday 19 August:	Stations P4 to P9.
Saturday 20 August:	Stations P10 to P12.
Sunday 21 August:	Stations P12 to P15.
Monday 22 August:	Stations P16 to P18.
Tuesday 23 August:	Stations P19 to P20.
Wednesday 24 August:	Stations P20 to P23.
Thursday 25 August:	Stations P24 to P26.
Friday 26 August:	Station P26, service mooring NRS02, Station PA-010. Start sailing east.
Saturday 27 August:	Keep sailing east.
Sunday 28 August:	Keep sailing east.
Monday 29 August:	Stop at P8 to do the bongos and one rosette. P4 for a rosette.
Tuesday 30 August:	Arrive at IOS at XXXX.
Wednesday 31 August:	Offload at IOS.

CRUISE TRACK:



SUMMARY/FINAL COMMENTS:

- Many thanks to everyone at IOS who have helped make this cruise a success: Kenny, Nina, Kelly, Mark, … your help is always greatly appreciated! Thanks for the extra hand (and backs!) while loading and offloading, and for your help setting up the lab before we left.
- Thanks also to Bruce, Mathew, Matthew, Martin, Kaylee, and Tom for fixing the winch. It was a big job and you guys did wonders with it.
- Thank you to Andrew for sending the weather forecast and the Grib file every morning!
- Very special thanks to Captain Kent Reid for his constant help with the program, and his very open mind towards science. I can't thank you enough …
- And thanks to *everyone* on board for such a successful and enjoyable cruise! The new galley crew did an amazing job, catering awesomely to the special dietary requests; Sheila and Vince took amazing care of us, as usual; the MCR crew was always available to fix everything we managed to break; the deck crew was always there to give a hand; and the officers "ran the show" like maestros!

Marie Robert

- I'd like to thank the captain and crew of the *Tully* for their assistance, excellent work, and upbeat mindset throughout the cruise. Thanks to the IOS team and the scientists onboard for their help and their humour on deck and in the lab. And finally, a great big thank-you to Marie for flawlessly organizing the entire cruise and for staying calm in the face of the inevitable tribulations of fieldwork.

Jade Shiller

- We'd like to thank the Captain and crew of the *Tully* for all their assistance and hard work throughout the cruise. Thanks to Marie Robert and the IOS science crew for having us on board to do this work and accommodating sampling needs.

Theresa Venello

- Thanks to the officers and crew of the CCGS John P. Tully for the work to make this a successful cruise. Special thanks to Marie Robert for all of the wire time and all those who helped carry the 24 ℓ carboys. Special thanks to Sara Zeidan from the University of Ottawa who helped with the collection and processing of the large volume Cs samples.

  Rick Nelson

- I would like to thank the winch operators and deck crew for their fine touch in deployment and retrieval of some awkward equipment - everything went smoothly - and to the officers of the bridge for some excellent station keeping, especially during the long 3000m MPS sampling.

  Moira Galbraith

- Many thanks to Kenny Scozzafava for setting up the kit while the Tully was still tied up at dock, really appreciated.

  Moira Galbraith

- We would like to thank all of those who assisted in the collection of DIC/Alk samples. Your help was truly appreciated.

  Glenn Cooper

- Thank you to the Captain, officers and crew of the JP Tully. I also want to thank Robert, Theresa, Steve, Krista and Rick for their help sampling. I really appreciate everyone who helped carry bottles to and from the incubator and all of the science crew for their encouragement. Thank you especially to Marie for her support and accommodating my sampling requests, IOS personnel for analyzing samples, Glenn for helping with the incubator and Sarah Thornton for providing science equipment.

  Amanda Timmerman

- As always, it was a pleasure to be involved in this cruise, and to work with our colleagues. We greatly appreciate all of the help we received – particularly in accommodating our objectives (thanks very much Marie!) and instrument setups, the additional efforts to collect and analyze Winkler O_2 calibration samples (thanks Moira!), and in overseeing the process of conducting radioisotope work on the ship (thanks Mike!). Thank you as well to everyone who helped to collect gas samples.
  We thank the entire crew of the Tully for their great assistance, and for taking such good care of us – as always.

  Robert Izett

- I would like to thank the science and cabin crew for making this experience memorable and a special thanks to Marie for making this all possible.

  Sara Zeidan

PROJECTS AND RESULTS:

Water masses – Marie Robert, DFO/IOS.

Last June there was a Haida eddy just north of P13 – P14 (see Figure 1). Unfortunately I haven't been able to download the new altimetry graph, but it seems that the eddy moved south and west and is now situated on P16, as seen in the Temperature Anomaly Field (Figure 2). Those anomalies were calculated with respect to the 1956-1991 averages. Figure 2 also shows the residual warm waters following the "Blob" – the warm water mass present in the NE Pacific since ~October 2013. Notice the presence of cold waters along the coast.

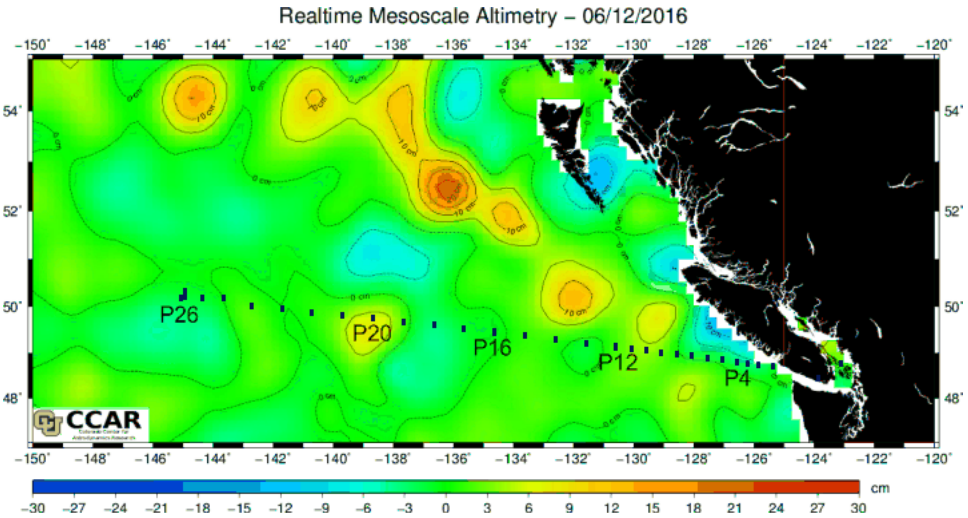


Figure 1: Altimetry on 12 June 2016 showing the small eddy around Station P20. Data from the Colorado Center for Astrodynamics Research.

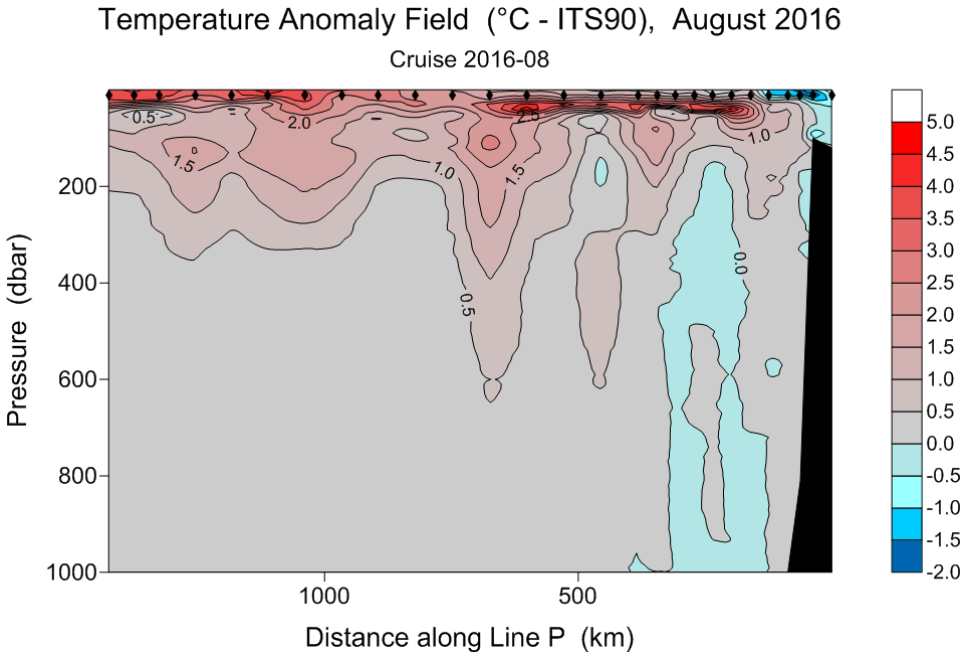


Figure 2: Temperature anomaly field with respect to the 1956 – 1991 averages for August 2016, showing the eddy signature at Station P16.

Jade Shiller UBC Line P – August 2016

Objectives:
Describe the taxonomic and metabolic diversity of the bacterial and viral communities in the cycling of major nutrients along Line P, focusing on the communities in the oxygen minimum zone.

Sampling summary:
At 5 stations (P4, P12, P16, P20, and P26),

1) 2 L seawater samples (at 16 depths) for high-resolution (HR) bacterial DNA sequencing were filtered.
2) 50 mL seawater samples were taken per depth to count the number of cells per milliliter using flow cytometry and single cell DNA analysis. Samples were aliquoted and preserved using glutaraldehyde and glycerol+trisEDTA, respectively.

Additionally, at 3 major stations (P4, P12, and P26), the following were sampled at four depths: 10, 500, 1000, and 2000 (bottom+10 at P4) across the oxygen minimum zone:

1) Large volumes (20 L; LV) at each depth were filtered to create genomic libraries of the bacterial communities.
2) After adding of iron chloride to the filtered water, the samples were filtered again for later virus analysis.
3) For viral counts, samples were taken and preserved using glutaraldehyde and betaine.
4) 50 mL seawater samples were taken per depth to count the number of cells per milliliter using flow cytometry and single cell DNA analysis. Samples were aliquoted and preserved using glutaraldehyde and glycerol+trisEDTA, respectively.

Comments:

All my lab objectives for this cruise were successfully fulfilled. The work area distribution was convenient for my sampling needs.

I'd like to thank the captain and crew of the *Tully* for their assistance, excellent work, and upbeat mindset throughout the cruise. Thanks to the IOS team and the scientists onboard for their help and their humour on deck and in the lab. And finally, a great big thank-you to Marie for flawlessly organizing the entire cruise and for staying calm in the face of the inevitable tribulations of fieldwork.

Line P - August 2016: Theresa Venello, UVIC (John Dower)

Objectives: Quantifying secondary (crustacean zooplankton) production along Line P using the chitobiase-method. Comparing production from the *Tully's* seawater loop system and 5 m rosette bottle production.

Sampling:
500mL of seawater was taken from 6 depths (5, 10, 20, 50, 150, 250 m) at all 7 major stations that have a bongo net cast (P2, P4, P8, P12, P16, P20, P26). All samples were collected on the way out to OSP. Loop seawater samples (500 mL) were also taken at each of these stations.

In addition, loop seawater samples were taken at P6, P10, P14, P19, P22, P24 to increase the spatial resolution of our production estimates.

Water was taken from the rosette, filtered through 54µm mesh and into 500 mL Nalgene bottles. Water samples were then 'spiked' with a homogenate made from ground krill and/or copepods (depending on what was in the bongo sample); filtered every three hours over a 12 hr period to create a decay of the moulting enzyme chitobiase. Samples were assayed and read using a fluorometer while on board.

Zooplankton samples were also collected from the rosette at P2, P4 and P26 by filtering whole Niskin bottles at three depths (5, 50, 100) through a 250/300 µm sieve for Evgeny Pakhomov at UBC.

Comments:
All of our sampling goals for this cruise were met.

We'd like to thank the Captain and crew of the *Tully* for all their assistance and hard work throughout the cruise. Thanks to Marie Robert and the IOS science crew for having us on board to do this work and accommodating sampling needs.

Mission 2016-08 CCGS JP Tully Aug 16 - 30, 2016: Cs-137 and I -129 Sampling – Rick Nelson, DFO/BIO.

An earthquake triggered tsunami on March 11, 2011 caused extensive damage to the nuclear generating station at Fukushima Japan resulting in the discharge of large amounts of Cs-137 and other radionuclides directly to the Western North Pacific ocean during the months following the accident. The radioactive plume was transported northeastward under the influence of the Kuroshio current and was expected to approach the Canadian coastline several years after the accident. A Canadian monitoring program was established to detect the arrival of Fukashima radioactivity in the water columns of the eastern North Pacific and the Arctic oceans.

Water samples were collected at stations occupied on the "Line P" missions on the CCGS J P Tully in June of 2011, 2012 and 2013. The program was expanded in 2014 to include both the Feb and Aug Line P missions and has continued until 2016.
Future participation is planned for the February and August line P missions for both 2017 and 2018.

Sampling 2016-08:

Five depth profiles were collected at stations P4, P10, P16, P21 and P26. Samples were collected at 500, 400, 300, 200, 150, 100, 50 and 5 meters. As the signal from Fukushima moves towards the coast and begins to slowly sink all 5 stations were sampled to 500 meters.
Sixty liter samples were collected at all depths.
In addition 60 liter surface samples were collected from the underway loop system after the ship was on station at P1, P2 P6, P8, P12, P14, P18, P19, P23, P24, P25. In addition a duplicate sample was collected at P26. A total of 53 samples were collected.
In addition 500 milliliter samples were collected for I-129 analysis from the rosette at Station P4, P10, P16, P21 and P26. A total of 40 samples were collected.
The samples for Cs were extracted onto KCFC (potassium cobalt ferrocyanide) ion exchange resin at flow rates of approximately 300 ml's per minute, and then sealed for return to the Bedford Institute of Oceanography.
The resin samples were then dried placed in appropriate counting geometries and the Cs-137 and Cs-134 radionuclides were determined by Gamma ray Spectroscopy using HPGE (high purity Germanium) detectors.

Thanks to the officers and crew of the CCGS John P. Tully for the work to make this a successful cruise. Special thanks to Marie Robert for all of the wire time and all those who helped carry the 24 ℓ carboys.
Special thanks to Sara Zeidan from the University of Ottawa who helped with the collection and processing of the large volume Cs samples.

Zooplankton sampling – Moira Galbraith, DFO/IOS.

11 shallow plus 5 deep Bongos and 3 MPS vertical hauls were achieved for a total of 31 zooplanktons collected. 1 teaspoon of zooplankton was taken from the biomass side of P4, P8, P12, P16, P20 and P26 250m Bongo samples and preserved in DNA grade 95%ETOH for U236 analysis by the University of Ottawa. Several deep water fish plus one tuna stomach were set aside into the minus 80 freezer for isotope analysis by UBC. UVic extracted euphausiids and large copepods from several Bongos for secondary production calibration.

The wet lab has a problem with leaking water pipes. Repairs to the wet lab plumbing plus the loop sink happened several times during the cruise. The latest leak in the wet has so far eluded the crew but appears to originate in the loop system somewhere and is running into the bulkhead between the two labs then emptying into the wet lab. The water staying in the wet lab is a result of both drains being inoperable: one drain is the highest point in the lab and the other is plugged solid.

There appears to be a film of oil or hydraulic fluid on the back deck, leading to awkward slips, flips and flies. This should be addressed; even though the majority of the slickness has been cleaned up there are still some spots where it is easy to slide.

The weather was very cooperative this trip allowing the collecting of all zooplankton stations and then some. Both winches worked well off the aft deck. The positioning of the Bongo winch to the starboard aft pad allowed for less heaving on the deployment and no interference with access to the portable lab on the port side. I would like to thank the winch operators and deck crew for their fine touch in deployment and retrieval of some awkward equipment - everything went smoothly - and to the officers of the bridge for some excellent station keeping, especially during the long 3000m MPS sampling.

IOS Oxygen analysis kits – Moira Galbraith, DFO/IOS.

The oxygen analysis suffered many pitfalls this trip. Many thanks to Kenny Scozzafava for setting up the kit while the Tully was still tied up at dock, really appreciated. The first set of standards and blanks ran well after a little glitch with the program was straightened out. Titrating the first set of samples went fairly smoothly after dealing with bubbles in the lines from high temperatures (over 26 C) in the lab causing all the reagents to gas out and form bubbles everywhere. There has got to be a better way to remove and/or prevent bubbles forming on the burette tips; what a pain.

After running standards and blanks (which were not great but passable) the computer program lost the standards file or incorrectly wrote the file which meant that the sample run would have incorrect parameters for running oxygen titration. Could not find the file that the program was pointing to, did not exist and even shutting the whole system down and rebooting did not change anything. It was speculated that this may be an error caused by the computer program having code to write over files at 12 midnight and the computer itself having the incorrect time and day in its register. Due to the computer glitch, all the previous parameters that Kenny had set up were also lost and everything had to be re-entered. This included finding the original config file and deleting it so the volt reading could be reset to zero; it was reading -1.81 volts. This was not something I could find in the manual but there was reference to the config file being auto-detected so it made sense to remove it to let the program reset itself.

While getting ready for the next batch of samples several days later, it was discovered that the NaOH dispenser was frozen; soaking in hot water has not helped (yet). I am suspecting crystals in the inner workings somewhere, will work on it on the way back in. This is one of the new dispensers and was working just fine that morning. Setting up the backup dispenser led to the discovery that the stem was too short to reach to the bottom third of the bottle so had to get a full NaOH and the stem from the newer one is not interchangeable with the old. The Mg dispenser is constantly getting bubbles in the pipette near the end and the replacement NaOH pipette drips; only the acid dispenser has behaved itself (so far).

When running the next set of standards it was determined that either the bulb was failing or the UV detector and may have contributed to the earlier somewhat okay blanks in the previous run. Because it was easier to switch out the detector, this was done first (plus remembering Kenny saying that one should rarely have to change bulbs) and appears to have worked. The next set of standards and blanks went well and was able to complete all titrations up to P26 and loops.

The majority of the duplicates are within .0005 of each other; therefore, I would say that the drawing of the oxygen's, shaking and subsequent treatment of samples has been good. All oxygen's received their double shake and water on top. Two flasks out of all the samples run were found to have bubbles in them at the time of processing. There are a lot of duplicates that have lower reading for the B flask which to me is counterintuitive.

I would recommend having more than two UV detectors on hand for long cruises and more trouble shooting help. The manual is a good start and I know it is a work in progress but need more. Another thing is to have the air conditioning working in the lab; it is not good for the reagents to be sitting in 25 plus temperature. Perhaps we should pack a good fan to keep the air moving in the lab.

Line P Cruise Report

There were three main purposes for attending the Line P cruise. The first objective was to obtain biological activity at the beginning, middle and end of the Line P sector. The second objective was to collect depth water samples and the last objective was to filter 20L of seawater through a KCFC in coordination with Richard's samples. All these objectives will help gain a greater understanding of the plume of radionuclides travelling through the Pacific Ocean from the Fukushima incident in 2011.

Biological activity samples were collected from the shallow bongos, placed in a glass 20mL vile and then filled with 95% Ethyl Alcohol. Biological samples were collected at P4, P12, P20 and P26. The depth water samples were collected at 5m, 50m, 100m, 150m, 200m, 300m, 400m and 500m each with a 2L sample. The KCFC samples were 20L surface samples, where the water was pumped through the resins for >6hr per sample station.

All of my objectives were completed, with a large array of samples collected throughout Line P. I would like to thank the science and cabin crew for making this experience memorable and a special thanks to Marie for making this all possible.

Carbonate studies – Glenn Cooper, DFO/IOS.

1) Seawater pH analysis:

Seawater pH was determined using the spectrophotometric method developed by Clayton and Byrne (Deep Sea Research, 1993). Seawater was collected directly from the rosette Niskins into 10cm path length glass cuvettes. Meta-cresol purple was used as the indicator dye and was validated prior to the cruise at Institute of Ocean Science (IOS). All work was performed in the temperature control lab on the John P. Tully.
The following major stations were sampled: P1, P2, P4, P12, P16, P20, and P26. One set of triplicate samples were taken at stations P1 and P2, whereas all other casts had two sets of triplicates. Replicates will be used to determine precision for the entire cruise. A calibration cast was performed at P22 where triplicates were taken from 5 Niskins which were closed at all the same depth of 2000m.

There are two different types of closing mechanisms material on the IOS rosette: metal springs which may or may not be coated, and silicon tubing. In collaboration with Roberta Hamme's group, we investigated if the different types of material had any impact on the following chemical parameters: pH, Dissolved Inorganic Carbon, Alkalinity and Oxygen. Replicate Niskins representing the different closing mechanisms were closed at two different depths at P17 (Table 1). Oxygen was sampled first, followed by pH and DIC/Alk samples. Duplicates were taken from each Niskin for oxygen and DIC/Alk. For pH, triplicates were sampled from each Niskin and analyzed immediately. Results from the experiment indicate that there was no effect on sea water pH due to the type of material used to close the rosette Niskin bottle (Table 1). Further results will follow once the dissolved oxygen samples and the DIC/Alk samples are analysed.

Table 1. The impact of closing mechanisms material on sea water pH (n=3/Niskin).

Sample ID	Depth (dbar)	Niksin #	Average (n=3)	Stdev	Closing Mechanism	Combined Average	Stdev
477	1000	3	7.2905	0.0004	Black spring		
487	1000	13	7.2896	0.0009	Metal spring	7.2900	0.0008
489	1000	19	7.2916	0.0005	Silicon tubing		
490	1000	20	7.2901	0.0018	Silicon tubing	7.2908	0.0014
491	100	21	7.7617	0.0004	Silicon tubing		
492	100	22	7.7612	0.0019	Silicon tubing	7.7615	0.0013
483	100	9	7.7592	0.0012	White spring		
488	100	14	7.7600	0.0002	Black spring	7.7596	0.0009

2) Dissolved Inorganic Carbon and Alkalinity sampling:

DIC/alkalinity samples were collected into 500ml glass bottles and preserved with 100ul of saturated $HgCl_2$ at the following stations: Haro59, JF2, P1, P2, P4, P12, P16, P20, P26. A calibration cast was performed at P22 where triplicates were taken from 5 Niskins, all of which were closed at same depth of 2000m. Stoppers were greased with Apeizon grease and taped closed with electrical tape, placed into a walk-in cooler until unloaded at IOS for onshore analysis. At P26, a complete extra set of samples were collected for archiving. At P17, duplicates samples were taken from Niskins that were used to investigate the impact of the closing mechanism material on sea water chemistry (see above section on pH). Duplicate DIC/Alk samples were taken and preserved with mercuric chloride, stored in a 4°C cooler until returned to IOS for analysis.
We would like to thank all of those who assisted in the collection of these samples. Your help was truly appreciated.

2016-08 Cruise Report – Amanda Timmerman – University of Victoria

Biological productivity is an important process controlling the export of carbon to the deep ocean. There are multiple methods to estimate production and I focused on two techniques: dissolved gas ratios and incubations. Dissolved gas ratios included measurements of oxygen, nitrogen and argon (ONAr) ratios and triple oxygen isotope ratios. Incubations included ^{18}O and dual $^{13}C/^{15}N$ additions.

ONAr: Samples were collected in duplicate at two depths within the mixed layer at P4, P12, P16, P20 and P26. Duplicate samples were also taken at PA-010 at 3, 7 and 10 m. ONAr samples collected on this cruise will be analyzed at the University of Victoria to obtain precise measurements of O_2/Ar.

Dissolved oxygen: Duplicate samples were collected at 5 m, 100%, 50%, 30%, 15% and 1% light levels at P4, P12, P16, P20 and P26. Duplicate samples were also taken at PA-010 at 3, 7 and 10 m. At P17 and P4 (return trip), oxygen samples were collected at 19 Niskins by IOS and UVIC to calibrate oxygen concentrations. Dissolved oxygen samples were analyzed on board using the Winkler titration method with a visual endpoint.

Triple oxygen isotope: Duplicate samples were collected within and below the mixed layer at P4, P12, P16, P20 and P26. The below the mixed layer depth was chosen based on the oxygen profile. Samples will be analyzed for the 16, 17 and 18 oxygen isotopes.

Dual tracer incubations, NH4, nutrients, chlorophyll: Samples were collected at 5 light depths (100, 55, 30, 10 and 1%) at P4, P12, P16, P20 and P26. Two sets of incubations were done using $NaH^{13}CO_3$ and either $^{15}NO_3$ or $^{15}NH_4$. Each set of samples was done in triplicate at 100% and single samples at all other depths. A blank and dark were collected at 100% light level for each ^{15}N nutrient. All incubations were incubated for 24 hours under a constant flow of seawater and then filtered. Duplicate NH_4 samples and single nutrient and chlorophyll samples were collected at the 5 light depths as well. To test if the Niskins modified with Viton o-rings and silicone tubing closure mechanisms affected production, an additional $^{13}C/^{15}NO_3$ incubation was collected from a non-modified Niskin for comparison.

Salinity: Samples were collected below the mixed layer, within the oxygen maximum and at 50%, 30%, 15% and 1% light levels at P4, P12, P16, P20 and P26.

^{18}O incubations: Triplicate samples were collected at 5 light depths (100, 55, 30, 10 and 1%) at P4, P12, P16, P20 and P26. Samples were spiked with ^{18}O labeled water and incubated for 24 hours under a constant flow of seawater. After 24 hours, the samples were collected into flasks and will be analyzed at the University of Victoria.

Phytoplankton: Samples were collected at a single depth in the surface water at P12, P16 and P20. The following preservatives were used: lugol, formalin and glut.

Niskin comparison: To improve phytoplankton sampling, Niskins 17-24 were modified with Viton o-rings and silicone tubing closure mechanisms, replacing black rubber o-rings and springs. To test if the changes affected the data, samples were collected from two modified and two unmodified Niskins from both 100 m and 1000 m for pH, DIC and oxygen concentration.

Acknowledgements: Thank you to the Captain, officers and crew of the JP Tully. I also want to thank Robert, Theresa, Steve, Krista and Rick for their help sampling. I really appreciate everyone who helped carry bottles to and from the incubator and all of the science crew for their encouragement. Thank you especially to Marie for her support and accommodating my sampling requests, IOS personnel for analyzing samples, Glenn for helping with the incubator and Sarah Thornton for providing science equipment.

Cruise Report – Robert Izett (Tortell Lab; UBC, Earth, Ocean & Atmospheric Sciences)

Objectives:

Our participation in this cruise was focused on quantifying the distribution of biogenic gases and optical properties in surface and subsurface waters along the Line P transect. We deployed a number of automated instruments for real-time analysis, and collected discrete depth profile and surface samples for subsequent laboratory analysis. A key aim of these efforts was to quantify net community production at high spatiotemporal resolution along the Line P transect – contributing to previous sampling efforts on the February and June trips of this year. We additionally conducted carbon-14 (^{14}C) uptake experiments to evaluate gross primary productivity

at the major stations. The cruise provided an opportunity to test and troubleshoot new instruments setups and methods as well.

Gas Measurements and Quantification of Net Community Production:

At the major stations (P4, P8, P12, P16, P20, and P26) we collected discrete profile samples for analysis of methane and nitrous oxide (N_2O), contributing to an almost-ten year time-series of these gases along the Line P transect. Surface samples were collected for N_2O analysis at approximately 40-mile intervals. Additional samples were collected from the lab seawater loop system for comparison between loop and Niskin (5 m) sampling for N_2O – loop sampling would enable us to obtain higher resolution of surface measurements if they prove indifferent to the Niskin results. As N_2O is a proxy for upward transport, these measurements will be used to estimate vertical water column mixing to the surface.

We deployed a membrane inlet mass spectrometer (MIMS) for underway measurement of mixed layer gas concentrations of dissolved nitrogen, oxygen, carbon dioxide, and argon. Of particular interest was the ratio of O_2/Ar, which enables quantification of surface ocean net community production. The discrete N_2O profile and surface samples will be used to correct underway O_2 and NCP measurements for the upward advection of low-O_2 water. The NCP data will be compared with Amanda Timmerman's (Hamme lab) NCP estimates derived from discrete O_2/Ar samples, and paired with measurements of secondary production made by Theresa Venello (Dower lab). We encountered (and overcame) a few technical issues with the MIMS setup early during the cruise, but otherwise obtained a high-quality data set.

We also continued our deployment and development of the Optode/Gas Tension Device (GTD) setup ("Miss Piggy") in the transducer space. A seawater pump was installed downstream of the instrument housing to increase the flow rate through Miss Piggy, and therefore reduce the residence time of seawater inside the chamber to less than one minute. Unfortunately, for reasons yet unknown, the GTD did not work during the cruise. We also encountered problems with the newly installed pump: the flexible rubber impeller ripped after just 8 days of use, causing the pump to become ineffective in circulating water through the setup. In spite of these issues, we did collect a relatively good O_2 data set from the optode on both the outbound, and inbound legs.

As during the previous February and June trips, we collected discrete samples from Miss Piggy in the transducer space and the seawater loop in the main lab for measurement of O_2 by Winkler titration. The purpose of this was two-fold: 1) for comparison/calibration of the optode, and 2) for examination of the offset in O_2 concentrations in the ship's seawater supply lines, relative to Niskin observations. The data from February and June showed that O_2 measured in the seawater lines (both in the lab and transducer space) is consistently higher than concentrations measured in the Niskin bottles, suggesting entrainment and dissolution of air/bubbles into the water. The data for this cruise are pending.

Optical Instrumentation:

We continued our measurement of optical properties from the seawater loop, including particulate back-scatter and spectrally-resolved absorption spectra. These measurements will be used to derive an algorithm for predicting particulate carbon concentrations and the relative abundance of different pigment classes in surface waters. We were unable to collect a complete dataset as a bulb died in one of the optical sensors at the mid-point of the cruise. However, the remaining sensor appears to have produced good data.

Finally, we used a Fast Repetition Rate Fluorometer (FRRF) to continuously measure active chlorophyll *a* fluorescence along the ship's track. These data can be used to infer rates of photosynthetic electron transport around photosystem II (as a proxy for gross primary productivity), and they also provide information on a number of phytoplankton photo-physiological properties. Data quality appears to be good from this sensor.

^{14}C Experiments:

We conducted ^{14}C uptake experiments for quantification of gross primary productivity at the major stations (P4, P12, P16, P20, and P26). These data will be compared with measurements of primary productivity made by Amanda using ^{13}C, and with Theresa's measurements of secondary production. The rad van was in good working order – thanks Mike for providing a new refrigerator/freezer!

Comments:

As always, it was a pleasure to be involved in this cruise, and to work with our colleagues. We greatly appreciate all of the help we received – particularly in accommodating our objectives (thanks very much Marie!) and instrument setups, the additional efforts to collect and analyze Winkler O_2 calibration samples (thanks Moira!), and in overseeing the process of conducting radioisotope work on the ship (thanks Mike!). Thank you as well to everyone who helped to collect gas samples.

We thank the entire crew of the Tully for their great assistance, and for taking such good care of us – as always.

Cruise Report August 2016: NOAA subsurface mooring NRS-02.

Sara L Heimlich, Oregon State University/NOAA PMEL Ocean Acoustics Group

RECOVERY:

Recovery of the NRS-02 mooring (Fig. 1) began at 09:02 PDT on August 26, 2016. Sea State was 1-2 with a WxN wind of 15kts. The Tully faced into the prevailing wind and held position approximately 600 m from the mooring location (50^0 14.9562'N, 145^0 08.9934'W) while the acoustic release deck set was programmed and the transponder was deployed. At 09:20, initial communication failed between the transponder and the acoustic release on the mooring. Over the next hour, several attempts were made as different solutions to the problem were tested. Finally, the entire system was replaced with a back-up deck set and transponder. Successful communication with the acoustic release was established 10:20. A total of 4 Slant ranges to the mooring were taken. By 11:10, the final mooring position was determined (Fig. 2); there was no indication of drift from the 2015 deployment location. The mooring was released at 11:15 and the 40inch syntactic foam float was observed at the surface by 11:30. Recovery operations were extremely smooth and problem-free. The RIB "Tully 1" was deployed to tie a tow line to the float line at 12:05, while the J.P Tully kept off the mooring. The mooring was in tow by 12:25. The mooring float was on board by 12:35. By 12:40, the float had been disconnected and hauling in the rest of the mooring commenced. The full mooring was aboard the vessel by 14:18. As the 3,000+ meters of mooring line was winched aboard, the H-26 hydrophone was removed and secured on deck, and the 'top' of the mooring re-built for re-deployment, including new hardware and chains and the H-18 hydrophone. The acoustic release SR45722 was removed and secured on deck at the very end of the recovery. The procedural outline for the mooring recovery was: Retrieve the 40 inch Syntatic Foam Float via a12 meter polyolefin line through the aft A- frame, using the crane; Secure the mooring on deck with and detach it from the bottom of the float; Retrieve the 50 meters of ¾" Nylon using the Capstan and aft A-frame; Recover the hydrophone, secure and transfer the 3543 meter section of 5/16" Vectran line to the spooling winch; Secure and separate the 3543 meter section of Vectran line and retrieve the smaller 180 meter remaining section of 5/16" Vectran line with the Capstan; Secure and retrieve the remaining 10 meters of ¾" Nylon line, 1 meter of chain, swivel and Acoustic Release with the capstan. At 14:30, the vessel set route for the deployment area, during which time the 'bottom' of the mooring was built, including the new acoustic release SR34391, which had been previously tested while on board.

DEPLOYMENT:

Deployment of the re-configured NRS-02 mooring began at 15:05 PDT on August 26, 2016. Sea State was 1-2 with a WxN wind of 10-15kts. Before deployment, the approximate final Target Anchor Position was determined (50° 14.956'N, 145° 08.993'W) and the approximate Intended Anchor Drop Point was determined (50° 15.0376'N, 145° 09.4381'W) with a calculated anchor fallback of 600m (Fig.3). The ship course over ground was 272° T. The buoy was deployed over the stern through the A-frame, via a block attached to the primary crane on deck. The float was in the water by 15:25. Tag lines were run to the sides of the A-frame, with an initial tag line on the bridle. Subsurface instruments were pre-attached to the top 50m of nylon flaked out on deck. After the buoy was in the water, the prepared line was allowed to payout. Once the float was fully deployed at ~0.5 kts, the line was run through the capstan as the ship steamed toward the anchor drop location at 1-2 kts. The mooring was played out and towed for just about 1.5 hours, and a Sea Catch quick release was used to release the anchor off the stern. The quick release operated slightly prematurely(less than 2 minutes), and the anchor was dropped before the intended Anchor Drop Point, at 17:03 PDT, resulting in a revised Anchor Drop Point location at 50° 15.0044'N, 145° 09.2509'W. After settling, the buoy position was reported as 50° 14.9321'N, 144° 52.360'W. This was calculated as 216m SE from the original intended mooring position (Fig.3). Final ranging on the mooring with the same acoustic deck set and transponder that was used successfully to locate the mooring before recovery, met without success. Ranging was aborted after half an hour (no attempt was made using the other deck unit system), in consideration of the time constraints for other research commitments that were pending. Aside from this failure and the premature release of the anchor deployment operations were very smooth.

ACKNOWLEDGEMENTS:

The NSR-02 mooring was safely deployed on this mission. The PMEL Ocean Acoustics group would like to extend a sincere thank you for the provided ship time, as well as the opportunity to collaborate with the scientists and crew of the TULLY. Our gratitude extends to IOS for their continued partnership, hard work, and cooperation that make this mooring possible. Special thanks to:

TULLY White Crew – CCGS, especially Captain Kent Reid and Bosun Bruce Wilson

Marie Robert – IOS, Chief Scientist

Moira Galbraith– IOS, Watch Leader (day)

Steve Romaine – IOS, Watch Leader (night)

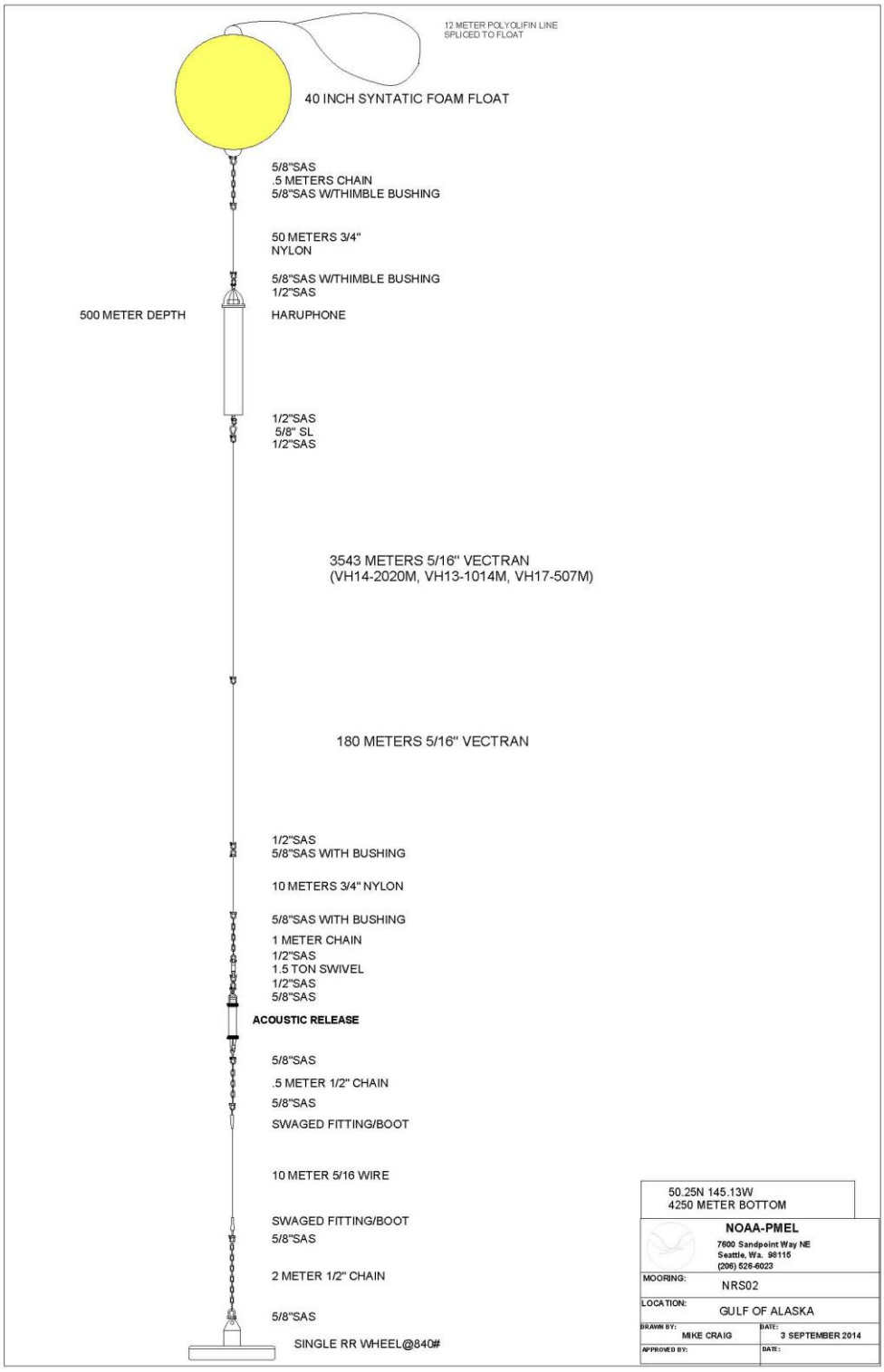


Fig. 1. NRS-02 mooring

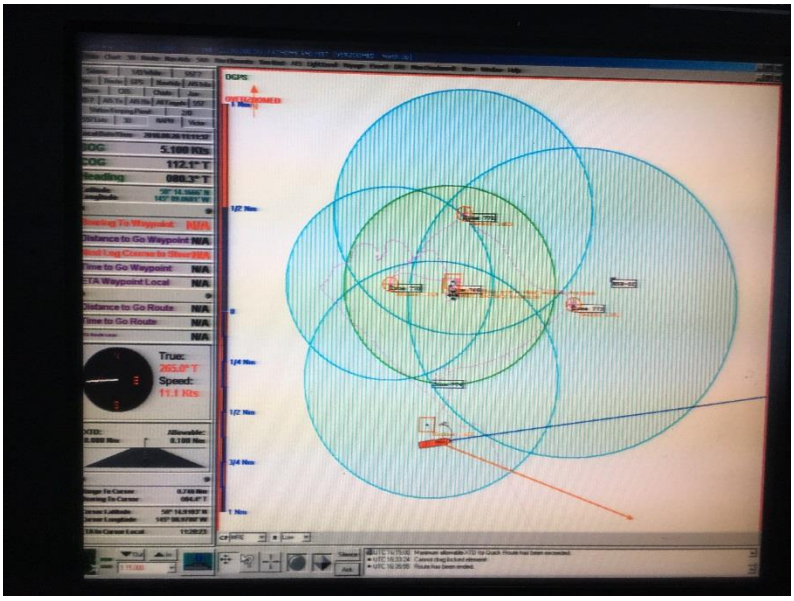


Fig. 2. Slant ranges to NRS-02 mooring

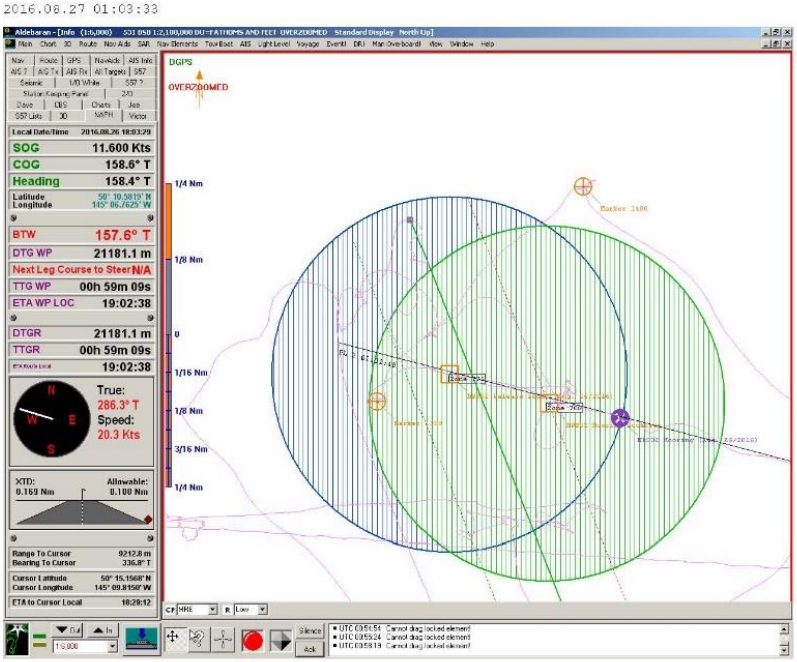


Fig. 3. Anchor Drop point and Final Mooring Location. Black line shows ship track line; large blue and green circles with stripes show 543m radius. Where the black line intersects the green circle on the left is the location of the Intended Drop Point; yellow square on the left shows the Actual Drop Point; small yellow square right shows the intended mooring location (same as previous location); small blue circle with white X shows the new final mooring location; small yellow circles with + inside show ranging locations.